How engineers can design the next 100 years with digital twins

By Bonga Ntuli

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Imagine being alive 100 years ago when fridges, microwaves, and hairdryers didn't exist.

Source: www.pixabay.com

You'd get around by horse and cart so you couldn't travel very far very fast. And if you had an infection, your doctor would likely prescribe blood-sucking leeches since Penicillin had not yet been discovered.

Much like we can't imagine what life was like 100 years ago, no one knows what the world will look like in 2122.

Will there be flying autonomous cars? Undersea megacities? Will we get around by teleporting? Who knows.

The difference between then and now is that we have digital twin technology that allows us to play and experiment with different scenarios and outcomes.

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Chetan Mistry 8 Dec 2022

With great power comes great responsibility

As engineers, we like to think big, like smart cities, affordable, safe, and dependable public transportation networks, and sustainable and resilient water systems that help society to deal with floods and drought while ensuring everyone has clean water to drink. We enjoy looking beyond the present to the possibilities of the future.

Every five or ten years, I look back on my career and think, ‘how did we do our job before?’ Similarly, engineers 50 years ago, 30 years ago, and even ten years ago didn’t envisage that we’d have technology that would give us superpowers to time travel to the future to design the best outcomes for society.

It’s easy to get carried away by what’s possible. And, while we should think big about what is possible for Southern Africa, there are a lot of little things we need to get right before we start talking about things like flying cars.

We need to “futureproof the fundamentals” — our water and energy infrastructure, road networks, and data-gathering and analysing capabilities.

And we can do this by laying the foundation for a digital twin of our infrastructure.

Measure twice, cut once with a digital twin

Bonga Ntuli, director, strategy at Royal HaskoningDHV

A digital twin is a virtual world that matches the real world in its complexity, scale, and accuracy. It’s an exact digital recreation of an object or environment, like a road network or underground water infrastructure — and there are so many things you can do in it.

If you’ve ever played *The Sims*, you’ve experimented with simulation technology. Your avatar self can do anything, be anything without consequences or reward in the real world. But what if you could make those simulations come true?

You’d have a superpower.

With digital twin technology, governments can build a model of cities and monitor the data pulsing through them to get real-time insights into the state of infrastructure. This data forms the foundation of the digital twin. And the more data points we have, the more solutions we can experiment with until we find the one with the biggest social, economic, and environmental impact.

The 'measure twice, cut once' proverb in carpentry teaches that measurements should be double-checked to ensure accuracy before cutting the wood. That is, before taking any action, we must carefully plan so that we do not waste time, energy, or resources correcting mistakes.

With a digital twin, city planners can see what would happen if they modified a city’s layout, planned a road, or changed the traffic systems.

They can compute not just one possible future but many possible futures.

And if it doesn’t work in the digital twin, it won’t work in the real world. Testing it out first means we prevent bad decisions. And the more ‘what-if’ situations we test, the more creative and effective the solution will be.

It’s how we measure twice and cut once.

Here’s an example:

How do you cater for more cars? Do you build more roads? Possibly. But what if there’s no budget or space for more roads? Could you optimise traffic flow in real-time to keep vehicles moving, avoid bottlenecks, and reduce emissions? You could, with a digital twin.

Or take water as another example. Many municipalities don't know where their pipelines are or the state they're in because records have been lost.

But we can fix this problem quickly by sending sensors into the water pipe network to determine a pipe's location, size, and capacity. We can then use that information to build an accurate digital map of the existing system. This would enable us to predict and manage demand and pressure, implement just-in-time maintenance, and avoid outages caused by burst pipes.

Our best starting point is to reverse-engineer and fix our existing infrastructure. We must take better care of it to increase its lifespan and buy time to build new infrastructure. As my colleague always says, it's cheaper to maintain infrastructure than it is to fix it, and it's cheaper to fix infrastructure than to replace it.

With load shedding at all-time highs and more water shedding on the cards, there's a sense of urgency to get it right the first time. We can't afford to get it wrong.

But the gap between where we are today and where we'd like to be is massive.

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Back to basics

We need to start thinking — and preparing — for the future. But we can't do that until we get the fundamentals right. We need to put time and effort into the groundwork today so that we can build infrastructure that's capable of serving the needs of future generations.

It starts with collecting, sharing, and using data appropriately. It will require coordinated collaboration between multiple stakeholders, including the public and private sectors and affected communities, to co-create solutions.

Most importantly, we need a strategy to create digital twins.

With an immutable overview of all work done on our infrastructure, we can start to build institutional memory and promote trust and transparency. We'd also eliminate wasteful expenditure, compound the return on investment, and ensure sustainable outcomes for today and the next 100 years.

The work involved in building digital twins would also create jobs — not just for computer programmers and data analysts but for entry-level workers too. Together, we could make our cities more sustainable, efficient, and liveable for everyone.

It's true that we can't manage what we don't know, but we can start with what we do know, and we can gather more data as we go because the more data we have, the more digital twins we can build, the more people will understand their value. It will spark a movement, and we cannot yet understand how fast that's going to go.

ABOUT THE AUTHOR

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